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(19)

(54) IRRADIATION APPARATUS FOR THERAPEUTIC TREATMENT OF DERMATOSES

(71) We, PATENT - TREUHAND GESELLSCHAFT FUR ELEKTRISCHE GLUHLAMPEN MBH, of 1 Hellabrunner Strasse, 8 Munchen 90, Federal Republic of Germany, a German body corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an irradiation apparatus for therapeutic treatment of dermatoses which is particularly suited for the irradiation of patients who suffer from psoriasis and parapsoriasis. The apparatus can be assembled from several component parts which contain one or more structural units.

Psoriasis is a widespread chronic affection of the skin from which 2—3% of fair-skinned people suffer and for which up to now only an unsatisfactory therapy could be offered. Only in recent years a new method of treatment has been developed which has a curative effect. There is involved a photochemical therapy (Journal "Hautkrankheiten", Vol. 50, No. 14 (1975), pages 627—629; "The New England Journal of Medicine" No. 291 (1974), pages 1207—1211). It was found that exposure of the patients to long-wave UV radiation in connection with administering a specific photoactive medicament, which increases the sensitivity of the human skin to long-wave UV radiation, succeeded in producing curative results. In this connection it is of importance, that the therapeutic treatment need not necessarily be carried out stationarily, but can be administered in an ambulant manner instead, that it is easily practicable, and that the periods of exposure for the patient are relatively short.

The long-wave UV radiation used for irradiation should have its maximum, if possible, at about 365 nm. Irradiation systems for therapeutic treatment of psoriasis have become known, wherein the radiation is generated by a plurality of fluorescent lamps, if desired, by lamps having a violet glass bulb. For this, the lamps are arranged on a horizontal panel, in tunnel form, or, preferably, in a cabin closely surrounding the patient (Arch. Dermatol, Vol. 107, May 1973). The diameter of such cabins should be kept small, because otherwise — due to the radiant intensity of the fluorescent lamps — the required dose for an effective therapy can be attained only with undesirably long periods of exposure. With so small a distance from the irradiation source, the shape of the body is also of importance, so that uniform overall irradiation of the body is no longer ensured. Halogen metal vapour lamps of higher radiant intensity than fluorescent lamps have likewise already been used for therapeutic purposes, not so much for the treatment of skin diseases, but rather for curing hyperbilirubinemia in newborn babies. Although the said lamps, which contained, in this case, besides mercury substantially titanium iodide, had — due to their filling — a satisfactory radiant output in the region of between 320 and 500 nm, there is utilized though for the stated purpose only the intense radiation in the blue region by coating the outer envelope or jacket with a blue phosphor (US—PS 3 821 576).

The present invention seeks to provide an irradiation apparatus which supplies the necessary composition of radiation for therapeutic treatment of psoriasis, providing high radiation output and uniform irradiation of the object.

According to the invention there is provided an irradiation apparatus comprising a halogen metal vapour arc tube arranged in a reflector, the arc tube containing iron halide as well as mercury as a fill component, and a filter glass having its maximum transmission in the UV-A region.

The arc tube preferably contains from 0.1 to 1.0 mg/cc of metallic iron, an amount of halogen which is equivalent to the amount of iron - (II) - halide, and from 0.006 to 0.6 mg/cc of tin - (IV) - halide. The transmittance of the filter arranged within or adjacent to the reflector in the direction of radiation may be $\tau \leq 0.03$ at a wavelength

of $\lambda = 310$ nm, and $\tau \geq 0.65$ at $\lambda = 340$ nm. Thereby is achieved that ultraviolet radiation emitted by the arc tube outside the UV-A region is substantially filtered off.

In special cases of therapeutic treatment, where the administration of medicaments should be omitted, it is of advantage if the ultraviolet radiation also contains a UV-B component besides UV-A, i.e., radiant emission in the wavelengths between 315 and 280 nm. The UV-B component necessary for therapeutic treatment is obtainable by optimizing the position of the pass band of the filter. Depending on the UV-B component required, the filter arranged within or adjacent to the reflector in the direction of radiation may have a transmittance of $\tau \leq 0.05$ at a wavelength of $\lambda = 270 - 315$ nm, of $\tau = 0.5$ at $\lambda = 295 - 335$ nm and of $\tau \geq 0.8$ at $\lambda = 315 - 355$ nm, the gradient of the short wave cut off of the filter being given by the pairs of values $\lambda = 280$ nm $\tau \leq 0.04$ and $\lambda = 340$ nm $\tau \geq 0.75$ or, $\lambda = 310$ nm $\tau \leq 0.03$ and $\lambda = 340$ nm $\tau \geq 0.65$.

The filters can be arranged so as to surround the halogen metal vapour arc tube as a sleeve or an outer envelope, or as a closure disk for the reflector.

In a single structural unit, the maximum value of the spectral distribution of radiation may correspond to a radiant intensity of 0.01 W/sr per 5 nm per watt of power input of the lamp. The radiant UV-A intensity (315 — 380 nm) amounts to approximately 20 mW/sr per watt of power input of the lamp.

The reflector may comprise a parabolic, trough-shaped mirror, its slope of curvature ranging between the parabolas $y^2 = 100$ x and $y^2 = 70$ x $- 30$. The trough-shaped mirror may be provided with reflective side portions inclined towards the vertical through $\alpha = 20°$ and may have vents which are arranged so that radiation cannot emerge unfiltered; it may be further provided with a mesh grid sealing off the reflector opening and serving as a protection against filter breakage. The halogen metal vapour arc tube may be arranged in the focal line of the reflector.

Suitably, the parts of the apparatus are assembled to form an irradiation apparatus by mechanical assembly techniques. It proved advantageous to combine three identical units to provide one part of the apparatus, and to assemble two parts, inclined towards the vertical through approximately 30°, and in parallel into a single irradiation apparatus for partial body irradiation or, alternately, to use four component parts in the manner described for overall irradiation of the body. The component parts can either by mobile or stationary and rotatable into all planes so as to permit exposure of the patients individually while standing, lying or sitting, or also simultaneous irradiation of several patients. The dose of irradiation in the UV-A region (radiant intensity × time of exposure) considered necessary for therapeutic treatment, is given with 1.4 — 4.8 J/cm². Said rose is realizable with the irradiation apparatus according to the invention with short exposure times in spite of large distance irradiation, because of the high radiant intensity of the high pressure arc tube containing iron halide in the effective UV-A region.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:—

Figure 1 shows a structural unit in accordance with the invention;

Figures 2a and 2b show the trough-shaped mirror of the structural unit of Figure 1;

Figure 3 shows a component part composed of three structural units;

Figure 4 shows the degree of spectral transmission of the filter glass(es);

Figures 5 and 6 show the spectral distribution of radiant intensity of the individual structural units of the apparatus with different filters used; and

Figure 7 shows an apparatus composed of four component parts each of which contains three structural units.

The structural unit shown in Figure 1 comprises a halogen metal vapour arc tube 1, a trough-shaped mirror 2 and a filter glass 3 shown in Figure 2b. The arc tube 1 of quartz glass has an inner diameter of 20 nm, an electrode spacing of 48 mm, a volume of about 16 cc, and is filled with about 30 mg of mercury, 0.5 mg of metallic iron, and an amount of iodine which is equivalent to the iron - (II) - halide, 1 mg tin - (IV) - iodide, and argon of 20 torr as the starting gas. The arc tube is operated with 3.5 A at 125 V and with a power input of 400 W. The arc tube is arranged on the focal line of the trough-shaped mirror 2. Figure 2a is a side view of the trough-shaped mirror, Figure 2b a section along the line AB. The trough-shaped mirror is designed so as to provide uniform radiant intensity in the place of irradiation at a distance of from 0.5 to 2 m from the structural unit. For this, the reflective side portions 4 of the trough-shaped mirror are inclined towards the vertical through angle α, for instance, $\alpha = 20°$. The mirror is suitably made of aluminium with the electrolytically oxidized aluminium layer. The slope of curvature of the trough-shaped mirror, which has been swaged (hammer-blown) and is shown in section along the line AB, ranges between parabolas $y^2 = 100 \times$ and $y^2 = 70 \times -30$. The trough-shaped mirror can be manufactured by deep-drawing or casting techniques. For the attachment of arc tube 1, the trough-shaped mirror 1 is provided with sockets 5. Openings 6 provide the necessary

ventilation of the trough-shaped mirror. Shutter 7 is provided to shield radiation which might eventually emerge sideways through vents 6. As a protection against breakage of the filter, a wire grid (not shown) is preferably used, mounted underneath filter 3 and having a mesh size of 10 × 10 mm and a wire thickness of 0.5 mm.

As shown in Fig. 3, several structural units are used, depending on whether partial or overall irradiation of the body is desirable. The structural units are preferably assembled in square or rectangular metal or plastic housings 8. Systems with three or four structural units proved to be of particular advantage. The arc tubes are preferably spaced at a distance of from 0.34 to 1.3 m from one another. This arrangement affords uniformity of projected light on the surface to be irradiated.

Fig. 4 shows the degree of spectral transmission of the filter. When emission of the system is required only in the UV-A region (380 — 315 nm), then a filterglass is used which has become known under the tradename Sekurit (corresponding to curve 1) having a thickness of preferably 4.5 mm (arrangement a). But when in addition a predetermined UV-B component (315 — 280 nm) is desirable, then all filters are suitable which have a transmittance ranging between curve 1 and curve 2. Filter glasses known under the tradename WG 295 (thickness 5 mm) and under the tradename Sanalux (thickness 3 — 5 mm) (arrangement b) proved to be particularly suitable in this region. Filters having a higher transmission factor at 280 nm should not be used because of the detrimental effect of short-wave radiation <280 nm (UV-C).

The following tables show radiant intensities in W/sr of a structural unit according to the invention for a power input of the halogen metal vapour arc tube of 400 W and 2000 W:

Emitter	400 W	
filter glass	arrangement a	arrangement b
UV–C (<280 nm)	<0.001	<0.01
UV–B (280–315 nm)	<0.02	0.4
UV–A (315–380 nm)	7	8
long-wave UV (315–400 nm)	11	12

Emitter	2000 W	
filter glass	arrangement a	arrangement b
UV–C (<280 nm)	<0.001	<0.1
UV–B (280–315 nm)	<0.1	2.4
UV–A (315–380 nm)	40	48
long-wave UV (315–400 nm)	67	75

Figure 5 shows the spectral distribution of the radiant intensity of arrangement a, Figure 6 that of arrangement b, for a 400 W unit. The figures show that the selected filter hardly influences the spectral distribution of radiant intensity in the UV-A region and in the blue spectral region. A difference in the two spherical distributions is however noticeable in the UV-B region. According to Figure 5, the arrangement a is practically without UV-B radiation, whereas arrangement b according to Fig. 6 emits UV-B radiation to an extent desirable for special cases. With the knowledge of radiant intensity in the UV-A region, it is possible to figure out the radiant intensity of UV-A at a given distance, for instance on a couch, by means of the known laws of physics of radiation.

Figure 7 shows a suitable embodiment of the irradiation apparatus. The arrangement of four component parts 9, including three structural units each, and forming two planes indicated towards each other, affords an irradiation of side surfaces of the object.

WHAT WE CLAIM IS:—

1. An irradiation apparatus comprising a halogen metal vapour arc tube arranged in a reflector, the arc tube containing iron halide as well as mercury as a fill component, and a filter glass having its maximum transmission in the UV-A region.

2. Irradiation apparatus as claimed in claim 1, wherein the arc tube contains from 0.01 to 1 mg/cc of metallic iron, an amount of halogen which is equivalent to the amount of iron - (II) - halide, and from 0.006 to 0.6 mg/cc of tin - (IV) - halide.

3. Irradiation apparatus as claimed in claim 1 or 2, wherein the transmittance of the filter arranged within or adjacent to the reflector in the direction of radiation is $\tau \leq 0.03$ at a wavelength of $\lambda = 310$ nm, and $\tau \geq 0.65$ at $\lambda = 340$ nm.

4. Irradiation apparatus as claimed in claim 1 or 2, wherein the transmittance of the filter arranged within or adjacent to the reflector in the direction of radiation is $\tau \leq 0.05$ at a wavelength of $\lambda = 270 - 315$ nm, $\tau = 0.5$ at $\lambda = 295$—335 nm, and $\tau \geq 0.8$ at $\lambda = 315 - 355$ nm, the gradient of the short wave cut off of the filter being given by pairs of values $\lambda = 280$ nm $\tau \leq 0.05$ and $\lambda = 340$ nm $\tau \geq 0.75$, or, $\lambda = 310$ nm $\tau <$ 0.03 and $\lambda = 340$ nm $\tau \geq 0.65$.

5. Irradiation apparatus as claimed in any one of claims 1 to 4, wherein the structural unit emits radiation having a spectral distribution substantially as shown in Figure 5, the maximum value corresponding to a radiant intensity of about 0.01 W/sr per 5 nm per watt of power input of the lamp, and the radiant intensity of UV-A (315—380 nm) amounting to approximately 20 mW/sr per watt of power input of the lamp.

6. Irradiation apparatus as claimed in any one of claims 1 to 5, wherein the reflector of a structural unit comprises a parabolic, trough-shaped mirror, its slope of curvature ranging between the parabolas $y^2 = 100 \times$ and $y^2 = 70 \times -30$ and being provided with reflective side portions inclined towards the vertical through $\alpha = 20°$.

7. Irradiation apparatus as claimed in claim 6, wherein the arc tube is arranged on the focal line of the trough-shaped mirror.

8. Irradiation apparatus as claimed in claim 6 or 7, wherein vents are provided in the trough-shaped mirror which are so arranged that radiation cannot emerge unfiltered.

9. Irradiation apparatus as claimed in any one of claims 6 to 8, wherein the trough-shaped mirror is provided with a mesh grid across its opening.

10. Irradiation apparatus as claimed in any one of claims 1 to 9, wherein the apparatus is assembled by mechanical assembly techniques.

11. Irradiation apparatus as claimed in any one of claims 1 to 10, wherein one part of the apparatus is composed of three identical units.

12. Irradiation apparatus as claimed in any one of claims 1 to 11, wherein the apparatus comprises four parts each having threee identical units.

13. Irradiation apparatus as claimed in any one of claims 1 to 12, wherein the apparatus is either mobile or stationary and rotatable into all planes.

14. An irradiation apparatus substantially as described herein with reference to the drawings.

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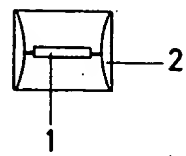

FIG. 1

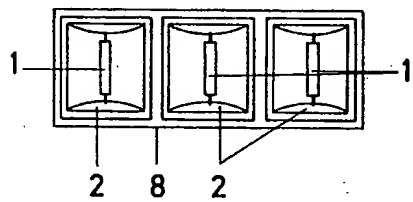

FIG. 3

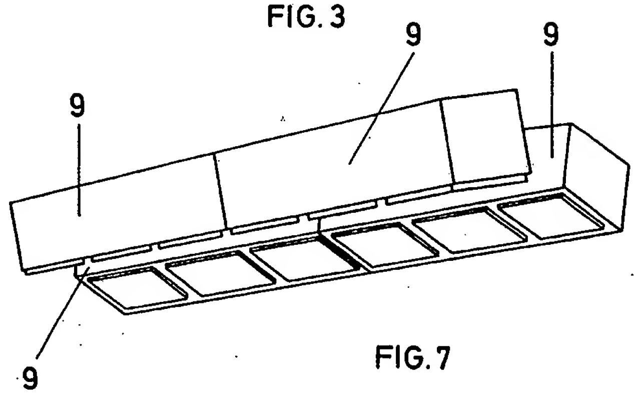

FIG. 7

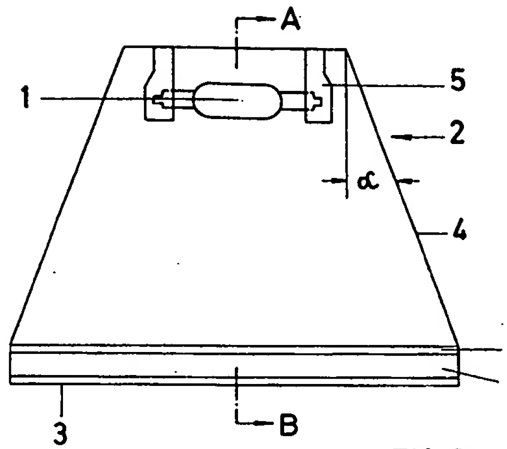

FIG. 2a

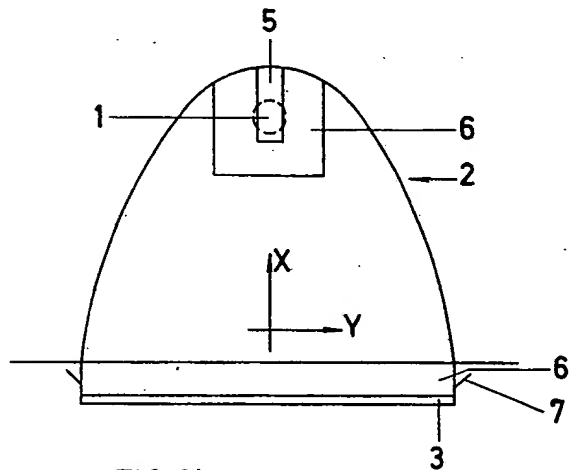

FIG. 2b

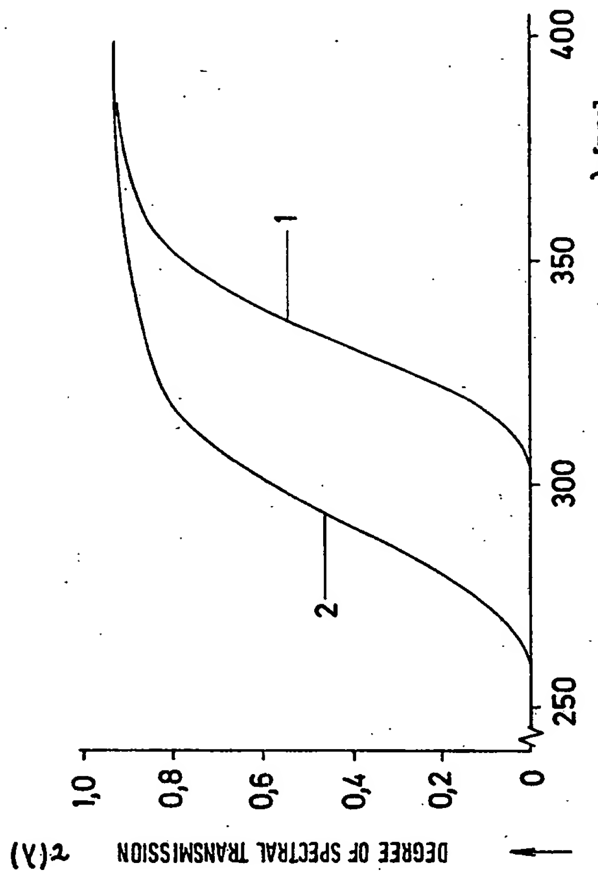
DEGREE OF SPECTRAL TRANSMISSION τ(λ)
1,0
0,8
0,6
0,4
0,2
0
250
300
350
400
λ [nm]
1
2

FIG. 4

1550757 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 5

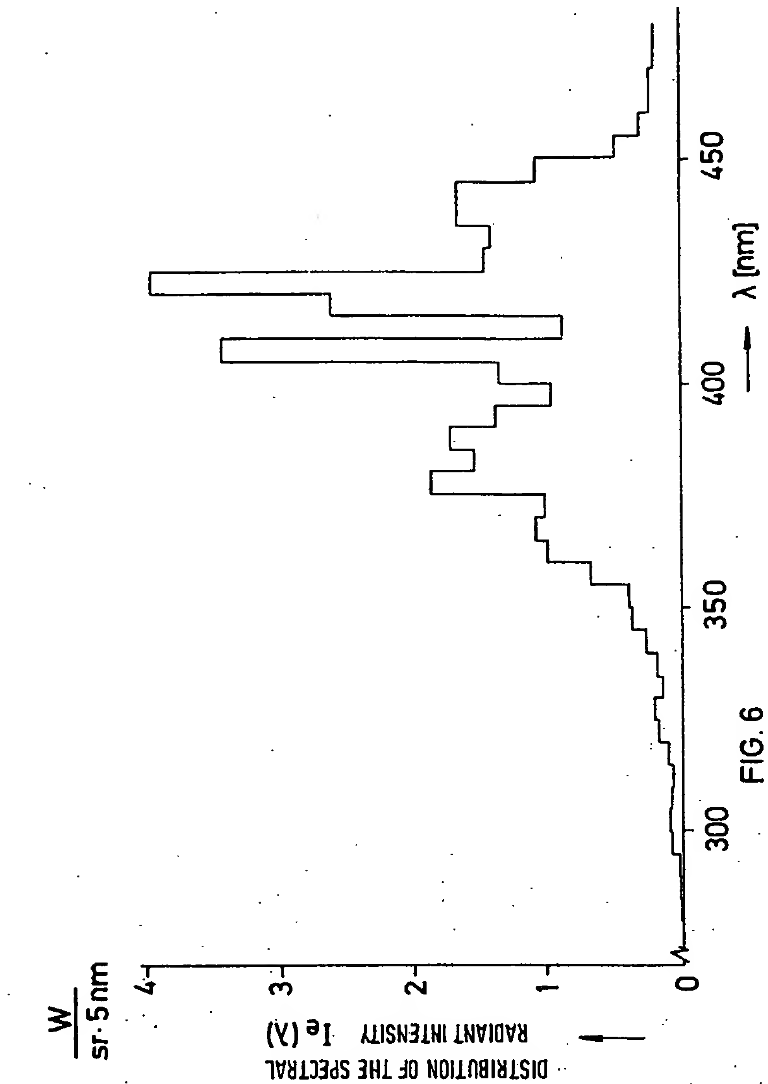

FIG. 6